Lesson 3: Hydrothermal Vents

**Overview:** Students have been studying deep sea organisms and the cycling of carbon from phytoplankton through the different levels. Today they will have an introduction to a chemosynthetic based producer as they learn about hydrothermal vent communities. Their understanding of what a producer is will be enhanced and they will see that patterns of energy flow still exist. Finally, they will draw a representation of a photosynthetic plant based food web, a photosynthetic phytoplankton based web, and a chemosynthetic bacterial based web to summarize and compare the different systems but apply the same vocabulary to each system.

**Standards:**

* LS3 (9-11) -8a Students demonstrate an understanding of Natural Selection/evolution by illustrating that when an environment changes, the survival advantage/disadvantage of some characteristics may change.
* LS2 (9-11) -4: Student demonstrate an understanding of matter and energy flow in an ecosystem by explaining how the chemical elements and compounds that make up living things pass through food webs and are combined and recombined in different ways.

**Objectives:**

1. Students will be able explain why there is an abundance of life in areas of hydrothermal vents.
2. Students will trace the cycle of carbon and energy from a chemosynthetic based producer to a large organism.
3. Students will be able to compare the flow of energy in a plant based system, a phytoplankton based system, and a chemosynthetic based system using the terms: heterotrophy, autotroph, herbivore, omnivore, decomposer, carnivore, primary and secondary consumer, producer, and predator in each one.
4. Students will draw and explain how symbiosis and mutualism allow tube worms and bacteria to survive near hydrothermal vents.

**Materials/Preparation Notes:**

* Photo of *Alvinella pompejana* on power point/screen (http://25.media.tumblr.com/tumblr\_m9bwxbSVJP1qc6j5yo1\_1280.jpg)
* DVD: *Volcanoes of the Deep Sea* Directed by Stephen Low. Volcanic Ocean Films inc. 2003. (chapter 9-11)
* 11x25 sheet of paper for each student
* Word bank

**Instruction:**

**Opening:**

Have a photo of *Alvinella pompejana* on the screen. Tell the students “This is Alvin” then tell them that instead of me asking questions, I want them to ask me questions about Alvin. Hopefully, some of the questions will lead to the discovery that;

* Alvin is a deep sea/hydrothermal vent worm
* Alvin is short for *Alvinella pompejana* (Alvin is a submersible)
* It is the most heat tolerant species on earth
* It is found on black smokers of hydrothermal vents in the deep sea
* It tolerates temperatures from a range of 22°C (72° F) to 80°C (176° F)
* It looks hairy because it has a mutualistic relationship with bacteria which form the “hairs” on its back and are thought to insulate the worm (the bacteria may benefit from mucus on the worms back
* Another way it protects itself from heat is by forming a very heat resistant tube that it lives in.

Can you think of ways that learning Alvin’s secrets could benefit humans?

**Activities:**

**1.** Brief discussion/introduction to hydrothermal vents:

* Ask students if they remember where hydrothermal vents are found
* What are characteristics of the vents? Extreme heat, chemicals, ….
* Do you think that there would be more or less organisms there? Why?
* What are they eating?
* Hydrothermal vents have a chemosynthetic based food web. What do you think chemosynthetic means?

2. I have a short video about hydrothermal vents that I would like to show you. As you watch this video I want you to look for the answer to these questions:

* Where do organisms get their energy from?
* What is the primary producer in this food web? What is a primary consumer?
* How do adult tube worms (not Alvinella) get their nutrients if they have no guts?

3. Show **DVD** *Volcanoes of the Deep Sea* from Chapter 9-11 (covers finding abundant life on black smokers after a volcanic event, energy from the radioactive elements in the earth, and microbes as producers which are consumed by shrimp)

* Draw a short food web on the board showing the relationships between bacteria (producers), and several levels of consumption, as well as the symbiotic relationships of the vent community (Worms and bacteria)
* Ask “Where does the carbon come from?” (bacteria)
* Where does the oxygen used by the bacteria come from ?(ultimately photosynthesis),
* Where does the sulfur and nitrogen come from (minerals in black smoker)

5. **Project**:

* Explain that they will be making a representation of the three different types of food/energy webs that they have studied
* Each student will be given a large sheet of paper to divide into thirds. On each third they will draw a food web for

1. A plant based photosynthetic system (from previous lesson can be any environment)

2. A phytoplankton based photosynthetic system

3. A chemosynthetic based system (hydrothermal vents)

* For each system they will need to use the same vocabulary words (cut and paste from a word bank –see attached or write them directly on the sheet).
* Students may begin the projects in class and finish as homework or at the beginning of the next lesson.

**Closing:**

I hope you enjoyed this brief introduction to one of the most extreme ecosystems on our planet. Tomorrow we will begin a culminating project that will showcase the concepts we have studied in our ecology unit.

**Assessment Notes:**

Students will be assessed using a rubric for their project. Questions about chemosynthesis and hydrothermal vents will be added to the final assessment.

Use one set of the following words for each of the three food webs:

|  |  |  |
| --- | --- | --- |
| Detrivore | Detrivore | Detrivore |
| Decomposer | Decomposer | Decomposer |
| Carnivore | Carnivore | Carnivore |
| Primary Consumer | Primary Consumer | Primary Consumer |
| Secondary Consumer | Secondary Consumer | Secondary Consumer |
| Tertiary Consumer | Tertiary Consumer | Tertiary Consumer |
| Producer | Producer | Producer |
| Mutualism | Mutualism | Mutualism |
| Autotroph | Autotroph | Autotroph |
| Hetertotroph | Heterotroph | Heterotroph |
| Herbivore | Herbivore | Herbivore |
| Omnivore | Omnivore | Omnivore |
| Symbiosis | Symbiosis | Symbiosis |
| Predator | Predator | Predator |

Rubric for three food/energy webs project:

|  |  |  |  |
| --- | --- | --- | --- |
| Score | Labeling | Web diagrams | Neatness |
| 3 | All 14 labels are used appropriately | Three diagrams have at least 4 trophic levels each. | Drawings/photos and arrows show relationships and direction of energy transfer and are easily interpreted |
| 2 | All labels are used but more than one are incorrectly applied | Three diagrams have less than 4 trophic levels but have enough organisms to use all labels | Difficult to read or follow the direction of relationships. Sloppy or careless cutting/pasting or drawing |
| 1 | More than two labels are missing or not used | Do not have more than 2 level in one or more web | Illegible writing. No arrows showing energy flow |
| 0 | No labels are used | Not done | Indecipherable |